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FRANCIS BAILY, Esq. Vice-President, in the chair.

John Eyre Ashby, Esq. B.A., of Homerton College, University of London, was balloted for and duly elected a Fellow of the Society.

The following communications were read:—

I. Translation of a Letter from Professor Hansen to G. B. Airy, Esq. the Astronomer Royal, on a New Method of Computing the Perturbations of Planets, whose Eccentricities and Inclinations are not small. Communicated by G. B. Airy, Esq.

“Sir,—I hasten to communicate to you a piece of astronomical intelligence of some importance. You are aware that all the methods that we possess for calculating the perturbations of the planets suppose that the eccentricities and inclinations are small, and that for those of the celestial bodies, which move in orbits very eccentric and very much inclined, we have been hitherto obliged to calculate the differentials of the perturbations for a great number of points of the orbits, and to integrate them by mechanical quadratures. I have just now discovered a method by which we can calculate the absolute perturbations,—that is to say, the perturbations for any time whatever, whatever be the eccentricity of the ellipse and the inclination of the orbit. For a first example of this method, I have calculated the perturbations of the comet of Encke produced by *Saturn*. The series to which my method leads are of such rapid convergence, that the perturbations of the longitude contain only forty-six terms, and the perturbations of the radius vector and of the latitude, somewhat fewer than this. I have reason to believe that it is impossible to reduce them to a less number of terms. Instead of writing here all the terms explicitly, allow me to represent generally the value for the time of perihelion passage.

“Here then is the first result of this kind, in which $n \delta t$ represents the perturbations of the mean longitude; u those of the hyperbolic logarithm of the radius vector, expressed in seconds, of

the above-mentioned comet; g' the mean anomaly of *Saturn*; and t the time, of which the unit is a Julian year.

$$\begin{aligned} n\delta t = & -0''06 - 1''7152 t + 1''56 \sin g' - 14''23 \cos g' \\ & + 23'41 \sin 2g' + 20'65 \cos 2g' \\ & - 6'39 \sin 3g' + 8'52 \cos 3g' \\ & - 2'65 \sin 4g' - 2'89 \cos 4g' \\ & + 1'43 \sin 5g' - 0'96 \cos 5g' \\ & + 0'32 \sin 6g' + 0'55 \cos 6g' \end{aligned}$$

$$\begin{aligned} u = & -1'05 - 0''1611 t + 0'61 \cos g' + 8'86 \sin g' \\ & + 33'10 \cos 2g' - 29'85 \sin 2g' \\ & - 9'01 \cos 3g' - 11'47 \sin 3g' \\ & - 3'41 \cos 4g' + 3'90 \sin 4g' \\ & + 1'74 \cos 5g' + 1'11 \sin 5g' \\ & + 0'32 \cos 6g' - 0'82 \sin 6g' \end{aligned}$$

“In the *Astronomische Nachrichten*, Vol. IX. No. 211, M. Encke has published for three periods the separate perturbations of this comet for each planet, and for the time of perihelion passage. We are, therefore, able to compare these perturbations with their preceding general value. But in this comparison it is necessary to remark, that in the calculation of the perturbations by mechanical quadratures, there arises in the perturbations of the epoch of the mean anomaly a term proportional to the time, which does not exist in the absolute perturbations, and that it is, consequently, necessary to determine the value of and to subtract this term. This being premised, x being the value of this term for a whole revolution of the comet; κ the number of revolutions; Δm the perturbations of the epoch of the mean anomaly; $\Delta \pi$ those of the longitude of the perihelion; $\Delta \Omega$ those of the longitude of the ascending node; $\Delta \phi$ those of the angle of the eccentricity ($e = \sin \phi$); $\Delta \mu$ those of the mean motion; i the inclination; we have

$$\begin{aligned} n\delta t = & \Delta m + \frac{(1-e)^2}{\sqrt{1-e^2}} \Delta \pi - 2 \sin^2 \frac{1}{2} i \cdot \frac{(1-e)^2}{\sqrt{1-e^2}} \Delta \Omega - \kappa x \\ u = & -\frac{2}{3} \frac{\Delta \mu}{\mu} - \Delta \phi \sqrt{\frac{1+e}{1-e}} \end{aligned}$$

“By substituting in these expressions the numerical values, which M. Encke has given at the place above quoted, we find for the period

Of 1819, Jan. 27-25 to 1822, May 24-0	$n\delta t = -67''81 - x$	$u = +94''11$
1825, Sept. 16-3	$= -79'30 - 2x$	$= +100'78$
1829, Jan. 9-72	$= -124'42 - 3x$	$= +54'54$

“For these four times we have the mean anomaly of *Saturn*, augmented for the sake of greater correctness by the great inequality; thus

$$\begin{aligned} g' = & 266^\circ 8' \\ = & 306 42 \\ = & 347 13 \\ = & 27 44 \end{aligned}$$

" If we substitute these values, as well as the values of t , 0; 3.322; 6.636; 9.952, in the preceding expressions of the absolute perturbations, we find for these four times,

$$\begin{array}{rcl} n \delta t & = & -25''.97 \\ & = & -46''.59 \\ & = & -8.12 \\ & = & -3.57 \end{array} \qquad \begin{array}{rcl} u & = & -66''.38 \\ & = & +28.94 \\ & = & +34.81 \\ & = & -12.52 \end{array}$$

" If we subtract from these the first-mentioned values, we obtain the perturbations for the three above-mentioned revolutions of the comet. Thus

$$\begin{array}{rcl} n \delta t & = & -20''.62 \\ & = & +17''.85 \\ & = & +22.40 \end{array} \qquad \begin{array}{rcl} u & = & +95''.32 \\ & = & +101.19 \\ & = & +53.86 \end{array}$$

" By comparing these values of u with those given before as found by M. Encke, we obtain the following differences:—

$$\begin{array}{rcl} & + & 1''.21 \\ & + & 0.41 \\ & - & 0.68 \end{array}$$

" By comparing in the same way the values of $n \delta t$, we find immediately

$$\begin{array}{rcl} 0 & = & +20''.62 - 67''.81 - x \quad \text{or} \quad 0 = -47''.19 - x \\ 0 & = & -17.85 - 79.30 - 2x \quad \quad \quad 0 = -97.15 - 2x \\ 0 & = & -22.40 - 124.42 - 3x \quad \quad \quad 0 = -146.82 - 3x \end{array}$$

" Hence we get $x = -48''.711$, by the substitution of which there result the following differences:—

$$\begin{array}{rcl} & + & 1''.52 \\ & + & 0.27 \\ & - & 0.69 \end{array}$$

of the perturbations of longitude. These differences, as well as those of the perturbations of the radius vector, are smaller than might have been expected, when we reflect on the total diversity of the methods employed, and the long calculations which the method of mechanical quadratures requires. Besides, my method is so simple that I am astonished at not having discovered it long ago; I have employed only eight days for the calculation of the preceding perturbations, the general expression of which belongs to every point of the orbit of the comet. I have thus succeeded in solving this problem, of which we till the present time possessed no solution.

" I beg you to communicate this letter to the Royal Astronomical Society, and to the Royal Society of Sciences, and to accept the expressions of high consideration, with which I am, Sir,

" Your very obedient servant,

" P. A. HANSEN.

" *Götha*, 14th Dec. 1842."

II. On a new Arrangement of a Vertical Collimator attached to the Altitude and Azimuth Instrument. By W. Simms, Esq.

The only essential respect in which the altitude and azimuth instrument now before the Society* differs from similar instruments by which it has been preceded is this. The azimuth or vertical axis is perforated and fitted with an achromatic object-glass having a diaphragm in its focus, so as to serve, in conjunction with the spirit-level upon the instrument, as a vertical collimator.

At present the spider lines in the diaphragm of the collimator form an acute cross, subtending an angle of about 30° ; but the preference of this arrangement over two parallel lines placed very nearly together, so as to present a narrow space for bisection, admits perhaps of question; my own habit being that of bisecting an angle by a line, leads me to give to it the preference, although I have found by experiment that very satisfactory results may be obtained by the other arrangement.

In this state of things, if the telescope be directed vertically downwards, the image of the cross in the collimator will be seen upon the diaphragm of the telescope; and the adjustment, independently of verticality which must be effected by the spirit levels attached to the instrument, consists in so rectifying the optical axes, that the centres, or intersecting points in the telescope and collimator, remain coincident during an azimuthal revolution.

The mode of adjustment, described in order, may be as follows, admitting, however, of variation at the pleasure of the observer.

1. It will be found convenient that the instrument be first generally levelled:—the azimuth axis by turning 180° in azimuth, and correcting by the feet screws of the tripod and the adjusting screws of the spirit levels; but, in all cases, if the error be not beyond the range of the scales, it is far better to leave these screws untouched, and to apply the correction by reference to the divisions upon the scales. The axis of the altitude circle must be rectified by the striding level, exactly in the same manner as in the transit instrument; all which, however, is too well understood to need a particular description in this place.

2. To adjust the line of collimation, bring the vernier marked A to 90° or 270° upon the azimuth circle, and, by means of the adjusting screws at the eye end of the telescope, make the middle vertical, or meridian line, bisect the angles of the collimator cross, turn 180° in azimuth, and correct half the error by the above-mentioned screws, and the remaining half by moving the object-glass of the collimator.

3. To correct the nadir point, set the vernier A to 0° or 180° upon the azimuth circle, 90° distant from its former position, and make the middle horizontal line bisect the angles of the collimator

* An instrument with the collimator attached was exhibited in the meeting room of the Society.

cross; turn 180° in azimuth, and correct half the error by giving motion to the telescope by means of the tangent screw, and half by moving the object-glass of the collimator. The micrometers should now be set to the zero points upon the altitude circle. By those, however, who prefer numerical corrections to mechanical adjustments, which, when extreme accuracy is aimed at, are always tedious and difficult to execute satisfactorily, the nadir point may be readily determined by reading the altitude micrometers with the circle in the reversed positions. The indications of the spirit-level fixed to the micrometer-bar must, of course, be carefully attended to in such a determination.

I shall conclude this notice by observing that the new application of the collimator does not deprive it of any uses and conveniences which it has in any other form, while at the same time it possesses advantages peculiar to itself. Its property, in common with the vertical floating collimator, of enabling the observer to set the axis of the altitude circle perfectly horizontal, irrespective of the riding level, is one which the level collimator does not possess. In common with the others, however, it affords a ready means of verifying and correcting the essential adjustments of the instrument without reference to any external object. An object adapted for such purposes should be both distant and well defined, conditions which imply a clearness of atmosphere perhaps not generally met with in any climate, and much less in that of our own country; moreover the collimator is equally available by night and by day: the light of a small lamp or taper being sufficient to render the lines visible.

But it has greatly the superiority, particularly in operations out of doors, over the vertical floating, and also over the level collimator, because the latter requires supports independent of, and equally steady with, that upon which the instrument itself is placed; things by no means easy of attainment under any circumstances, and to the scientific traveller often perfectly impracticable.

Neither is it a small advantage to dispense altogether with an additional instrument, which, to say the least, lessens the number of the traveller's cases, and with them his cares also. An extra instrument may by accident be injured, or through forgetfulness left behind, or for want of time to set up, or a steady support when set up, prove useless when it is most needed. But, by the new arrangement, the collimator becomes part and parcel of the instrument itself, and is so completely protected from injury that an accident could hardly impair or destroy it without at the same time destroying the entire instrument. Its introduction, too, into the perforated axis adds so little to the original cost of an instrument, that it may make a final claim on the score of economy.

III. Description of a Universal Instrument made by M. Ertel, of Munich, and presented to the Society by Alexis Greig, Esq. Vice-Admiral in the Imperial Russian Navy. By M. Ertel.

Translated from the German by Mr. Charles Knorre, and communicated by Admiral Greig.

This paper commences with a detailed statement of the cautions to be used in taking the instrument out of its cases, and of fitting it up for observation; and gives minute directions for rectifying and using it. It is accompanied by two drawings, the first of which is that of a projection parallel to the plane of the horizontal circle of the instrument; and the second exhibits in detail some of the essential parts of it.

IV. Occultations observed chiefly at Ashurst in the Year 1842. By R. Snow, Esq.

Date.	Star's Name.	Corrected Time of Immersion.	Moon's Limb.	Corrected Time of Emersion.	Moon's Limb.	
1842.		h m s		h m s		
March 22	α Cancri.....	8 10 45.22 [Sid.	dark.	....	....	Very well observed.
May 14	63 (p) Geminorum	....	....	12 3 11.5 [Sid.	bright.	Uncertain to 2 nd .
July 12	ϵ Leonis.....	....	....	15 54 31.0 [Sid.	bright.	
July 24	θ Aquarii.....	23 35 19.33 [Sid.	bright.	0 41 52.83 [Sid.	dark.	Emersion uncertain. Daybreak.
July 31	9 Tauri.....	20 48 $\pm$ [Sid.	bright.	21 31 2.94 [Sid.	dark.	At imm. Moon's limb low and undulating. Em. very good.
Sept. 26	B Tauri.....	....	....	22 59 4.0 [Sid.	dark.	Clouds about the Moon, and Moon low.
Oct. 23	B Tauri.....	6 48 42.56 [Sid.	bright.	....	....	Immersion beautiful; cloudy at emersion.
Nov. 12	π^2 Piscium.....	9 23 41.3 [M.Time.	dark.	....	....	} Observed at Somerset House. Beautiful.
ditto.	π^1 Piscium.....	9 46 42.4 [M.Time.	dark.	....	....	
ditto.	π^1 Piscium.....	....	....	10 18 3.3 [M.Time.	bright.	
Nov. 22	ζ Cancri.....	....	....	1 56 56.0 [Sid.	dark.	
ditto.	d^2 Cancri.....	8 19 16.6 [Sid.	bright.	....	....	

The Long. of Ashurst is..... $0^{\circ} 1' 10.1''$ W.; the Lat. $51^{\circ} 15' 53''$ N.
Somerset House.. $0^{\circ} 0' 27.0''$ W.; — $51^{\circ} 30' 34''$ N.

V. Observations on the (apparently periodical) Variations in the Lustre of certain Stars of the First Magnitude. By T. Forster, Esq.

The author has had his attention directed to the subject of the apparently periodical variations of brightness in certain of the stars, since the year 1824; and he has at every opportunity continued to multiply observations for the determination of this point in Belgium as well as in Italy and England. He has been induced to lay before the Astronomical Society the results of his inquiry, by the additional interest which has been lately given to the subject by the researches of Sir John Herschel.

Under the conviction that all recorded facts are useful, especially in the infancy of any particular inquiry, he has extracted

from his note-books the observations which he has at different times made on several stars, notwithstanding their rudeness and the imperfections of their arrangement, with the hope of aiding an investigation into the nature and variations of star-light.

After trials of several photometrical methods of arranging the stars in order of brightness, he has of late adhered to the simple and natural comparison made with the unassisted eyes, from a conviction of its superiority to all other methods, and he trusts that habit has conferred thereon a sufficient degree of accuracy to render the observations useful.

The first stars which attracted particular attention, on account of the striking variations observed in their apparent lustre, were α *Orionis*, *Aldebaran*, and *Procyon*, and to these were afterwards added *Capella*, *Rigel*, and α *Lyræ*.

From a series of corresponding observations in April and May 1824, the following results were obtained, *Sirius* being added to the list on account of the varying difference between his lustre and that of the others.

The order of apparent brightness of the above stars, from more than twenty observations, in April and May 1824, was as follows for that epoch, the degrees of difference being marked by the number of vertical lines between the stars :*—

Sirius |||| *Capella* | α *Lyræ* | *Procyon* | *Rigel* = *Aldebaran* | α *Orionis*.

The correctness of the above comparison the author thinks can be relied on with great confidence, as nearly two months were devoted to it, the observations being continued nearly throughout every night, yet the arrangement is not in accordance with present observations. *Rigel* is, for example, equal to *Aldebaran*, and *Capella* (after *Sirius*) is at the head of a list of which α *Orionis* is at the bottom, while the magnitude of *Sirius*, by the most accurate measurement, was about four times that of *Capella*. The difference of colour between α *Lyræ* and *Aldebaran* renders their comparison subject to some uncertainty.

The relative lustre of the same stars with *Pollux* in November 1824, from many observations, was as follows :—

Capella | α *Lyræ* | *Procyon* | *Rigel* | *Aldebaran* | α *Orionis* || *Pollux*;

the most striking difference being between the last two, and there being a difference between the lustres of *Rigel* and *Aldebaran*, which were before equal. Now, as the sum of the differences between *Capella* and α *Orionis* in May is equal to 4, and in November is equal to 5, the whole difference from *Capella* to α *Orionis* must have increased one-fourth; and this the author takes to have happened from the decreasing lights of both α *Orionis* and *Aldebaran* at once; and he suggests the propriety of remarking in future whether in general the respective lustres of any given

* Where no lines occur it is indicated that the stars are nearly of the same lustre.

number of changing stars vary contemporaneously or alternately, the latter being rendered improbable by the distance of the phenomena in question.

The author obtained some anomalous results from a comparison of brightness of some stars in the summer of 1824, by means of the time of their first becoming visible after sunset; this test sometimes, with stars of different colours, seeming to reverse the order obtained by the former method of direct comparison by the eye.

In November 1827, the order of lustre, as observed at Boreham, in Essex, was as follows:—

Capella | Procyon=Rigel | α Orionis=Aldebaran.

In 1834, at Naples, the order was

Capella, Arcturus, α Lyræ || Rigel, Procyon | α Orionis, Aldebaran | α Aquilæ.

(The precise date of the above observations was omitted in the note-book, though the author believes it to be in the declining summer).

In September 1834, at Rome, the order was, from many observations,

Arcturus, Capella, α Lyræ | Rigel, Procyon | Aldebaran, α Orionis.

In November 1835, at Aix-la-Chapelle, the order was

Capella | Rigel=Procyon | α Orionis, Aldebaran.

(The observation of *Aldebaran* was bad).

In February 1837, the order was

Procyon=Rigel | Aldebaran || Pollux | α Orionis.

The author suspects some error in the above, finding, in November 1837, the order to be

Rigel=Procyon | Aldebaran= α Orionis.

January 16th, 1838,

Rigel=Procyon, α Orionis | Aldebaran | Pollux=Castor.

January 6th, 7th, 16th, and 17th, 1839,

Sirius |||| Capella | Rigel | Procyon | Aldebaran | α Orionis |
Pollux=Castor=Regulus=Bellatrix.

The above observations were frequently repeated with the same results.

January 22d, 1839,

Sirius |||| Capella= α Lyræ | Rigel=Procyon, Aldebaran | α Orionis ||
Arided, Pollux=Regulus.

August 10th, 1839, while registering the numerous and brilliant meteors which the author has annually seen on this night since the year 1810, the following order of lustre was observed:—

Arcturus | α Lyræ || α Aquilæ || Arided.

November 11th, 1839, the order, as observed at Schäärbeck in Belgium, was

α Orionis = Rigel | Procyon | Aldebaran.

December 11th, 1839 (the night brilliant),

Rigel | α Orionis = Procyon || Aldebaran.

July 6th, 1840, the comparative lustre (observed by various instrumental means) was

α Lyræ || α Aquilæ || Arided.

July 29th, 1840,

Arcturus = α Lyræ || α Aquilæ || Arided.

January 9th, 1841, (a remarkably fine night),

Sirius |||| Procyon = Rigel | Aldebaran = α Orionis.

The observations were at this period suspended by the illness of the author, and were again resumed early in the year 1842.

March 1842, at Tunbridge Wells, the order was

Capella | Rigel | α Orionis | Aldebaran.

December 28th, 1842, at Bruges,

Sirius |||| Rigel, Procyon | α Orionis, Aldebaran.

January 1st, 2d, 3d, and 4th, 1843, at Bruges,

Capella, α Lyræ | Procyon, Rigel | α Orionis, Aldebaran.

The author hopes to be able to offer to the Society, at a future time, some more observations put together in a tabular form, and to accompany the observations with some historical notes respecting the changes in the colour and magnitudes of the stars.

Vol. XIV. of the Memoirs is now published, and may be had of the Assistant Secretary, at the Apartments of the Society. Price to Fellows Ten Shillings.

Vol. XIII. is now in the Press, and will be published in the course of the present year.

